IMPROVING RED SNAPPER MANAGEMENT AND SEAFOOD TRANSPARENCY IN THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Erin Taylor Spencer: Improving Red Snapper Management and Seafood Transparency in the Southeastern United States
(Under the direction of John F. Bruno)

Robust, accurate data about fish harvest is essential to developing sustainable policies that protect stocks while supporting the fishing and seafood industries. Unfortunately, there are large gaps in knowledge regarding how many fish are caught and what happens to those fish once they reach the dock. My thesis addresses two issues facing the snapper grouper fishery in the Southeastern United States: lack of data in recreational fisheries and the rate of seafood mislabeling. First, I investigated the rate of seafood mislabeling of red snapper using DNA barcoding. I found 72.6% of samples were mislabeled, indicating widespread mislabeling of red snapper on the South Atlantic coast. Second, I surveyed recreational anglers to assess perceptions of electronic reporting and found positive views of using apps and websites to report catch. These results inform fishers, consumers, and managers, and help facilitate the development of sustainable fisheries policies.

To my family, given and chosen, whose support of my academic adventures has never wavered.

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LIST OF ABBREVIATIONS

Apps	Cell phone applications
BLAST	Basic Local Alignment Search Tool
COI	cytochrome c oxidase subunit 1 gene
FDA	Food and Drug Administration
IUCN	International Union for Conservation of Nature and Natural Resources
MFC	MyFishCount
MRIP	Marine Recreational Information Program
MSA	Magnuson Stevens Fishery Conservation and Management Act
NCBI	National Center for Biotechnology Information
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PCR	Polymerase Chain Reaction
PSA	Proportional standard error
SAFMC	South Atlantic Fisheries Management Council
SEDAR	SouthEast Data, Assessment, and Review

CHAPTER 1: Fishy Business: Red Snapper Mislabeling in the Southeastern United States

Introduction

Seafood mislabeling in the United States has been recognized for decades: a 1997 press release by the United States National Seafood Inspection Laboratory stated 37% of fish tested between 1988 and 1997 were mislabeled (Ropicki et al., 2010). Sixteen years later, the mislabeling rate remained at over 30%, with one-third of over 1,200 samples nationwide mislabeled according to Food and Drug Administration (FDA) guidelines (Warner, 2013). Recent assessment of sushi restaurants in Los Angeles found mislabeling rates as high as 47%, with some species mislabeled up to 77% of the time (Willette et al., 2017). Despite growing public awareness about the practice of seafood fraud, rates of mislabeling remain high, indicating that there is still economic incentive to mislabel along the supply chain, while lack of awareness and/or enforcement allows the practice to continue.

Labeling of seafood is dependent on species' identity, country of origin, production method, and potential eco-labels (Buck, 2010). Each of these factors presents an opportunity for mislabeling as consumers, especially in the United States, are generally unfamiliar with seafood production (Jacquet and Pauly, 2008). Restaurants and businesses can exclude information about the origin of the product, which can lead to consumers receiving a product that is of lesser value than the desired species (Khaksar et al., 2015; Stiles et al., 2013). Seafood fillets can be extremely similar in taste, texture, and appearance, allowing fraud to pass undetected by the consumer (Ropicki et al., 2010).

Unintentional mislabeling occurs when species are misidentified or when information is lost along the supply chain. One example is accidental assignment to a species with a common vernacular name, such as labeling a red-colored vermillion snapper (*Rhomboplites aurorubens*), as “red snapper”, which is a different species (*Lutjanus campechanus*) according to FDA guidelines (Willette et al., 2017). Intentional mislabeling allows retailers label less-desirable species as more profitable ones, or to mask the sale of illegally captured species (Jacquet and Pauly, 2008). In 2009, Florida restaurants sold imported catfish as grouper, one of the most popular finfishes in the state. The restaurants paid only $2.50 per pound for the catfish, whereas domestic grouper cost $11 to $12 per pound (Vasquez, 2009).

Seafood fraud, whether intentional or unintentional, weakens public trust, compromises consumers’ ability to adhere to dietary restrictions, and poses public health concerns (Ling et al., 2008; Miller and Mariani, 2014). Mislabeling makes it impossible for consumers, especially children and pregnant women, to monitor their intake of high-trophic level species that could contain elevated levels of mercury (Marko et al., 2014). A previous study found tilefish, a species that the FDA warns consumers against eating due to its high mercury content, substituted for red snapper (Warner et al., 2012). Additionally, a fish that seems to be readily available but actually mislabeled leads the public to believe the fish stock is plentiful, regardless of the true state of the stock (Marko et al., 2004). This is particularly critical for popular seafood like red snapper, where the South Atlantic stock is considered overfished and is undergoing overfishing (SEDAR, 2016). If mislabeling occurs before landing data is collected, commercial landing data could be artificially inflated for in-demand species, and artificially low for substituted species (Di Pinto et al., 2015). This could affect management efforts by potentially allowing unregulated overharvesting of substitute species (Carvalho et al., 2011; Cawthorn et al., 2018). Continuing to

sell mislabeled species also keeps demand for the product high, which in turn encourages more mislabeling to supplement a small supply (Cox et al., 2012).

Lastly, mislabeling undermines efforts to promote consumption of sustainable seafood. Increasing education and awareness about the decline of wild-caught fisheries has led to a rise in consumers wanting to make environmentally-sustainable choices when buying seafood (Marko et al., 2011). A number of seafood certification and education programs have arisen worldwide, including the Sustainable Seafood Initiative, Seafood Watch, Seafood Choice Alliance, and the Marine Stewardship Council. Seafood certification programs are a way for people to engaging in marine conservation initiatives, and 72% of respondents in a United States survey said they would be more likely to purchase seafood labeled as "environmentally responsible" (Logan et al., 2008). However, the success of certification programs depends on the integrity of labeling: seafood substitution can undermine initiatives intended to provide sustainable seafood options to consumers (Gulbrandsen, 2009; Stawitz et al., 2017).

Although seafood fraud is widely documented in the literature, many studies are limited by small sample sizes or restricted to small geographic regions, such as a city. Additionally, many studies analyze a few samples from many different species, making it difficult to draw conclusions about mislabeling trends of a single species.

We measured the frequency and distribution of red snapper mislabeling and assessed how mislabeling rates vary between vendor type and state in the Southeastern United States. Red snapper is one of the most widely mislabeled species in the U.S. and one of the most popular and controversial fisheries in the South Atlantic and Gulf of Mexico (Cowan et al., 2011). Despite being declared over fished in the late 1980s, red snapper remains among the most valued fisheries in the South Atlantic and Gulf of Mexico, and the stock is currently managed by a

rebuilding plan to restore stocks to sustainable levels (Goodyear, 1988; SEDAR, 2016). In the study region in 2016 alone, commercial red snapper landings were valued at $2,565,290 dockside (NOAA, 2017). But somehow, the red snapper on the dock is not ending up on plates at the same rate: red snapper is mislabeled up to 77% of the time (Warner et al., 2012; Marko et al., 2004). According to the U.S Food and Drug Administration, only *Lutjanus campechanus* can legally be marketed as "red snapper", but previous studies have found the name colloquially used for a wide range of other fish, including species outside the snapper family (Marko et al., 2004).

This study measured red snapper mislabeling throughout the Southeastern coast of the United States to test the hypotheses that there are differences in mislabeling rates among states and vendor types, and that substituted species typically have healthier stocks than red snapper.

Materials and Methods

Collection

Seafood labeled as red snapper was collected from March-May 2018 from sushi restaurants, fish markets, and grocery stores in North Carolina, South Carolina, Georgia, and Florida (Fig. 1). For a holistic view of regional mislabeling, the number of samples collected from each state was loosely proportional to the length of the coastline. We collected 66 samples, with 20 samples from North Carolina, 15 from South Carolina, 4 from Georgia, and 27 from Florida. 22 samples from grocery stores, 25 from fish markets, and 19 from sushi restaurants. Sites were sampled only once, with the exception of two vendors who sold both filleted and whole "red snapper", in which case both products were collected and tested. Our study defined mislabeling in terms of incorrect identification of the species, but the scope of mislabeling can extend to other information like country of origin, farmed or wild caught, and more (Di Pinto et

al., 2015). Samples either needed to be physically labeled “red snapper”, or verbally confirmed as “red snapper” by a vendor employee. To simulate the experience of a consumer, if we asked an employee for red snapper and the employee indicated a specific product, it was included as a sample regardless of whether it was physically labeled “red snapper”. For example, when asked for red snapper, one grocery store employee indicated a fillet was red snapper, so that sample was collected despite it being physically labeled as mutton snapper. In sushi restaurants, only sashimi or rolls specifically marketed as “red snapper” were included. No samples only labeled as “snapper” were included unless an employee confirmed it was red snapper. A small piece of each sample was preserved in 95% ethanol and stored for processing in the lab. The specific location of vendors sampled varied within each state due to availability of “red snapper” products for sale.

DNA Extraction and Polymerase Chain Reaction (PCR)

For each sample, 20 mg of fish tissue was placed in a 1.5 mL microcentrifuge tube with 180µl ATL Buffer and 20µl proteinase K and incubated at 65°C for one hour. Samples were vortexed approximately every ten minutes during incubation. We added 200µl AL Buffer, vortexed, incubated at 55°C for ten minutes, then added 200µl ethanol. After transferring the resulting liquid to a DNAeasy Mini spin column, samples were placed in a centrifuge at 8,000rpm for one minute. Samples were run in the centrifuge twice more: first after adding 500µl Buffer AW1 at 8,000rpm for one minute, then after adding 500µl of Buffer AW2 at 14,000 rpm for three minutes. Flow through was discarded from spin columns after each centrifuge run. Spin columns were then transferred to a new microcentrifuge tube, eluted with 20µl of diH_20, incubated at room temperature for five minutes, then centrifuged at 8,000rpm for one minute.

PCR was used to amplify a fragment of the cytochrome c oxidase (COI) gene, which has been shown to be a strong diagnostic marker of fish identification to the species level (Wong and Hanner, 2008; Willette et al., 2017). One µl of each sample's DNA was added to separate 0.2 ml illustra puReTaq Ready-To-Go PCR bead tubes, along with the primer cocktail consisting of 1.3µl each of COI_F1, COI_F2, COI_R1, and COI_R2 PCR primers. One control PCR bead tube was used as a control to ensure primers were not contaminated with DNA. To bring the overall volume to 25µl, 19µl of distilled water was added to the PCR bead tubes (20µl was added for the control). After ensuring the PCR beads in the tubes were dissolved, tubes were placed in the thermocycler using the following protocol adapted from Willette et al. (2017).

Analysis of PCR amplified products and sequence analysis

We used gel electrophoresis to assess the results of PCR processing. 50 mL of 1X TAE Buffer and 0.5g of agarose powder were mixed and heated until the agarose was fully dissolved. We added 3µl of ethidium bromide was added before pouring the mixture into the gel tray. We mixed 1µl of 6X loading dye with 5µl of each sample, added each sample to the gel, and ran the chamber for 30 minutes at 100V. If the PCR reaction was determined successful, PCR products were shipped to Eton Bioscience in Durham, North Carolina, for purification and sequencing. Using 4Peaks software, we selected at least 300 base pairs and identified each sample to the species level with the Basic Local Alignment Search Tool (BLAST) on the National Center for Biotechnology Information (NCBI) website (http://blast.ncbi.nlm.nih.gov/Blast.cgi). Every identity with 98% confidence or above was considered a positive identification. Of 66 total samples, 4 were contaminated with bacteria and were unable to be identified. Positive identifications were determined for the remaining 62 samples. Sometimes the COI gene is not enough to differentiate two species, specifically between rose and lane snapper (*Lutjanus*

guttatus/synagris) and Malabar blood and crimson snapper (*Lutjanus malabaricus/erythropterus*). In these cases, samples were noted as being either species. Chi square tests and two-proportions z tests with Bonferroni corrections were used to see if the proportion of mislabeled samples was significantly different between vendor and state.

Results

Identity of substituted species

Of 62 samples, 45 (72.6%) were mislabeled. Eleven different species were substituted for red snapper (Table. 1) and 29 of the mislabeled samples (64.4%) were another species of the family Lutjanidae. One third of mislabeled samples were tilapia.

Mislabeling by vendor type and state

Grocery stores were least likely to sell mislabeled red snapper (Table 2). Six species, including red snapper, were represented in grocery store samples. Seafood markets had largest number of unique species, with nine species, including red snapper, represented. 31.2% of mislabeled samples from markets were vermilion snapper. Of samples collected in markets and grocery stores, fillets had a marginally significant higher mislabeling rate than whole fish ($p = .046$). Of 12 whole fish collected from grocery stores and super markets, eight were correctly labeled (66.7%), compared to only nine of 32 fillets (28.1%)

Every sample from sushi restaurants was mislabeled, with five different species being sold as red snapper. Sushi restaurants were the only vendors to substitute tilapia for red snapper, and 83.3% of sushi samples were tilapia.

There was not a significant difference in overall mislabeling rates by vendor type ($p = 0.4604$). However, when vendor types were directly compared to each other using a two-proportions z test and adjusted using a Bonferroni correction, there was a significant difference in mislabeling rates between grocery stores and sushi restaurants (adjusted $p = 0.01209$).

Although Florida had the lowest rate of mislabeling, there was not a statistically significant difference in mislabeling rates among states ($p = 0.8131$).

Stock status of substituted species

Out of 13 substituted species (if we consider those that are indistinguishable between two species—*Lutjanus guttatus/ Lutjanus synagris* and *Lutjanus malabaricus/ Lutjanus erythropterus*— as separate species), six were not native to the continental United States (46.2%) (Table 1). Of the ten substituted species assessed by the IUCN red list, nine were listed as less threated then red snapper. Vermilion snapper is the only species that is considered as at risk ("Vulnerable") as red snapper.

Discussion

Our findings were consistent with studies that assessed red snapper mislabeling rates in other parts of the United States. Marko et al.'s 2004 study across eight states found 17 of 22 samples mislabeled (77%), commonly replaced by lane or vermilion snapper. Fourteen years later, despite extensive media coverage of the topic and presumably increased public awareness, the rate of red snapper mislabeling is still over 70%. Like Marko et. al (2004), we found that about half of all samples were species not native to North America. Of 45 mislabeled samples, 68.9% were species native to other parts of the world. The mislabeling rate of sushi restaurants in

our study (100%) was concordant with results from Willette et al. (2017), which reported all red snapper sushi samples mislabeled.

Florida had the lowest rate of mislabeling, and Florida samples were removed from analysis, the overall mislabeling rate would jump from 72.6% to 83.3%. This regional trend is similar to Warner et al. (2013), who found that Miami, Florida had lower rates of red snapper mislabeling (38%) than the United States West Coast (100%), which is geographically further from a commercial red snapper fishery. While the South Atlantic commercial red snapper fishery was closed during the sampling period, the primary commercial red snapper fishery in the Gulf of Mexico was open at the time of collection. Ease of accessibility to fresh fish from the Gulf of Mexico could account for lower rates of mislabeling in Florida.

How closely mislabeled species related taxonomically to red snapper varied by vendor type. When mislabeling occurred, grocery stores were most likely to sell species closely related to red snapper. 81.8% of mislabeled grocery samples came from the same genus as red snapper (*Lutjanus*), compared to 43.8% of market samples. Only 11.1% of sushi samples were species of genus *Lutjanus*.

Fillets were more likely to be mislabeled than whole fish, likely because it is easier to pass off a variety of species as plain white fillets rather than whole fish with distinguishing morphological features. Of the four whole fish that were mislabeled, one was a rose/lane snapper, one was a silk snapper, and two were vermilion snapper. All three species have roughly similar coloring and body shape to red snapper which could decrease the likelihood that consumers would detect fraud (Fig. 2).

All substituted species, with the exception of vermilion snapper, were considered less threatened than red snapper by the International Union for Conservation of Nature and Natural

Resources (IUCN) (IUCN, 2018). Both red and vermilion snapper are considered "Vulnerable", which means the IUCN considers the species threatened with extinction. Despite a similar IUCN listing, there are differences in the stock status of red and vermilion snapper. According to stock assessments in 2015 and 2016, red snapper is overfished in the South Atlantic and Gulf of Mexico, and are undergoing overfishing in the South Atlantic (SEDAR, 2016). In contrast, a 2012 stock assessment found that vermilion snapper is not overfished and are not undergoing overfishing in the Gulf of Mexico or the South Atlantic (SEDAR, 2012). Where red snapper is significantly below their target population, vermilion snapper are close to their target population levels, suggesting that they are a more sustainable seafood option than red snapper.

Our results suggest that purchasing whole fish from grocery stores is the best way to avoid red snapper mislabeling. There was some redundancy, however, in the grocery store chains that were sampled. Although samples came from different geographic locations, some grocery store chains were sampled repeatedly. For example, of the 22 grocery store samples, seven were from Publix (five were correctly labeled), and four were from Whole Foods (all correctly labeled)—both of which are grocery chains that emphasize seafood sustainability in their marketing materials. Disproportionate sampling of grocery stores that have better seafood traceability could result in artificially lower mislabeling rates.

We were also limited by the availability of samples–sometimes it was difficult to find vendors who sold red snapper. Some markets, especially in North Carolina, who advertised selling local seafood that stressed that they did not carry red snapper because it was not in season in the South Atlantic. Four employees in fish markets in the study region explained why it was important to eat local fish that were in season, and suggested we try a different species of fish that was similar in texture and taste to red snapper.

Although isolated, there were examples of either misidentification or overt deception when purchasing samples for this study. One North Carolina seafood market employee said they caught the whole "red snapper" off the dock that morning, even though commercial red snapper season was closed in North Carolina at the time of collection. An employee at another market assured us that a fish labeled as vermilion snapper was red snapper, then pulled a different fish from under the table to wrap up for purchase that was later identified as silk snapper.

Further research into mislabeling rates at each stage of the supply chain (fisher, distributor, or vendor) is critical to developing policy to combat mislabeling. Although our study assesses mislabeling rates by vendor, we were unable to account for retailors that had the same distributor. It is possible, for example, that two sushi restaurants could unknowingly receive mislabeled "red snapper" from the same food provider, or that a seafood market could get fish mislabeled by a fisher.

Understanding the scope, scale, and trends of seafood mislabeling is important for consumers, fisheries managers, and participants in the seafood supply chain. Testing large sample sizes of commercially popular seafood species could indicate whether the economic value of those fisheries is overinflated by the inclusion of artificially inflated seafood sales. Regular, strategic testing (and retesting) could also point to seasonal trends, such as whether a species is more likely to be mislabeled when commercial seasons are closed. Disseminating mislabeling data could also encourage vendors and consumers to more closely assess where their fish is coming from, and could inspire vendors to test their own products to check that they are not receiving mislabeled products from their suppliers. Additionally, encouraging consumers to learn what to look and ask for in their seafood incentivizes vendors to ensure they are not selling mislabeled products.

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TABLES AND FIGURES

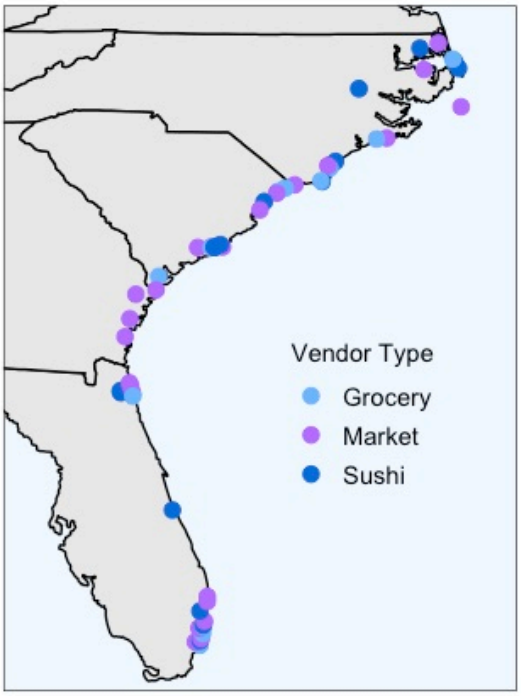

Figure 1: A map of the sample sites by vendor type.

Table 1: The name, range, and IUCN red list status of species substituted for red snapper.

Species	**Common name**	**Number Identified**	**Native range**	**IUCN status**
Oreochromis niloticus	Nile tilapia	14	Africa	Least concern
Lutjanus malabaricus/ Lutjanus erythropterus	Malabar blood/ crimson snapper	12	Indo-Pacific	Not assessed
Rhombopiltes aurorubens	Vermilion snapper	5	Atlantic	Vulnerable
Lutjanus guttatus/ Lutjanus synagris	Rose/lane snapper	3	Pacific (rose) and Caribbean, Atlantic, and Gulf of Mexico (lane)	Least concern
Pristipomoides multidens	Goldband jobfish	3	Indo-Pacific	Least concern
Lutjanus analis	Mutton snapper	2	Caribbean, Atlantic, and Gulf of Mexico	Near threatened
Ocyurus chrysurus	Yellowtail snapper	2	Caribbean, Atlantic, and Gulf of Mexico	Data deficient
Lutjanus vivanus	Silk snapper	1	Atlantic	Least concern
Oreochromis mossambicus	Mozambique tilapia	1	Africa	Near threatened
Morone chrysops	White bass	1	U.S. and Canada	Least concern
Pinjalo pinjalo	Pinjalo snapper	1	Indo-Pacific	Least concern

Table 2: Mislabeling rate by vendor type and state.

Grocery	55.0%
Market	62.5%
Sushi	100.0%

Florida	57.7%
Georgia	75.0%
South Carolina	75.0%
North Carolina	90.0%

Figure 2: Comparison of similar snapper species. Many snapper species are difficult to tell apart, even as whole fish. For example, lane snapper (top) resembles red snapper (middle). There is also variation in coloration of red snapper, as seen in the two red snapper samples (middle and bottom), which makes positive identification even more challenging.

CHAPTER 2: Snapper/Grouper Fisher Perceptions of Electronic Reporting in the South Atlantic

Introduction

Recreational fishing has substantial economic, environmental, and cultural significance worldwide. Defined as fishing activity where the primary intention is not to generate food or income, recreational fishing (also known as angling) has greatly increased in many marine fish species in the last 50 years (Ihde et al., 2011). For many coastal fish stocks in industrialized nations, recreational harvest surpasses commercial harvest, and it is estimated 11% of the world's population participates in recreational fisheries (Arlinghaus et al., 2016; Arlinghaus et al., 2015). This results in billions of fish caught every year through recreational fishing alone (Brownscombe et al., 2019)

The economic impacts of marine recreational fishing in the United States are significant. In 2014, marine recreational fishers spent $4.9 billion on fishing trips nationwide, and another $28 billion on fishing rods, tackle, boats, and other fishing equipment (Lovell et al., 2016). In the Southeastern United States alone (defined as North Carolina, South Carolina, Georgia, and Florida), total annual expenditures exceed $10.6 million and the recreational fishing industry supported 113,328 jobs (Lovell et al., 2016). The economic impact is also significant at a local level: within North Carolina's 19 coastal fishing counties, tourism (including recreational fishing) is one of the top three sources of local income. In 2016, 1.9 million recreational anglers spent $1.7 million which contributed to 15,069 North Carolinian jobs (DMF, 2017).

The ecological impacts of commercial fishing were historically thought to greatly outweigh those of recreational fisheries, but recent research strongly suggests recreational fishing

can have significant impacts on stock abundance, age and size distribution, and habitat quality (Arlinghaus et al., 2016; Mcphee et al. 2002). Unlike many commercial fisheries, recreational fisheries can target nearshore habitats that are important food sources and nursery grounds for many species (Cooke and Cowx, 2004; Jackson et al. 2001). Although about 60% of fish caught recreationally are released, an average of 18% of released fish suffer stress-induced post-release mortality (Cooke and Cowx, 2006; Bartholomew and Bohnsack, 2005). Post-release mortality can vary greatly between species, gear type, depth caught, and season, with some species exhibiting mortality rates over 65% (Muoneke and Childress, 1994). High levels of recreational fishing pressure can lead to the collapse of a stock, which could have long-term impacts on community and habitat structure (Post, 2013). A 2004 study found that recreational harvest of populations of concern can greatly outweigh commercial harvest, accounting for as much as 64% of harvest of those species in some parts of the United States (Coleman et al., 2004). Additionally, a study of Atlantic salt marshes found that loss of predators targeted by recreational anglers resulted in an increase of herbivorous marsh crabs, who then decimated native marsh grasses (Altieri et al., 2012).

Strategic, long-term management of fish stocks is critical to preserving both fish and the fishing industry. Fisheries managers use a collection of regulations to alleviate fishing pressure on stocks, including catch limits, seasonal closures, and size limits (Farmer and Froeschke, 2015). However, establishing effective regulations relies on good data, and there are a number of hurdles in quantifying the amount of fish caught in recreational fisheries. First, recreational fishers are often spread out along the coastline, including off many small, private docks, rather than aggregated at commercial ports that would make it easier to centralize sampling (McCluskey and Lewison, 2008). A phone survey of recreational blue crab fishers in Maryland

and Virginia found 61-83% of trips were made from private-access locations, and those fishers would therefore be left out of surveys conducted in public-access sites (Ashford et al., 2010) Second, fishing effort varies greatly by season, with weather conditions, and between anglers, meaning that survey results from one angler are not representative of the larger population (McCluskey and Lewison, 2008).

The current method of data collection under the National Oceanic and Atmospheric Administration (NOAA), the Marine Recreational Information Program (MRIP), was implemented in 2008 following the reauthorization of the Magnuson Stevens Fishery Conservation and Management Act (MSA) in 2006 (Breidt et al., 2010). MRIP uses three surveys to estimate catch and fishing effort: The Fishing Effort Survey, a random mail survey of fishing households; the For-Hire Survey, a phone survey of for-hire fishing captains; and the Access Point Angler Intercept Survey, an in-person survey of anglers at marinas (NOAA, 2018). However, MRIP can result in high levels of error in stock assessments due to limitations in data (Brick et al., 2012). For example, avidity bias can arise in in-person surveys, where avid anglers are surveyed more frequently because they have a higher likelihood of being intercepted by interviewers, potentially skewing data on fisher behavior and economic impact (Thomson, 1991; Jiorle et al., 2016). In 2018, proportional standard error (PSE) of estimates of red snapper catch by state in the South Atlantic varied from 21.6% - 73.7%, with >50% PSE considered as a "very imprecise estimate" (NMFS, 2019). Large variations in estimated catch can lead to limited recreational fishing seasons and mistrust of management efforts by anglers who feel like their catch is restricted based on unreliable data (SAFMC, 2018).

Electronic reporting of catch through cell phone or tablet applications (apps) is an emerging method to increase accuracy of catch data and engage anglers in citizen science efforts.

A projected 70% of the global population are predicted to use smartphones by 2020, meaning mobile data-collection will be widely accessible to anglers worldwide (Venturelli et al., 2016). Reporting apps are a low-cost and highly accessible way to gather fisheries data in real-time, with the potential to increase angler education and trust in reporting activities (Crandall et al., 2018). Electronic reporting is also a way to collect data in real-time from anglers, which decreases the risk of recall bias over time. For example, a comparison of recreational angler diaries and mail surveys found anglers overestimated the number of fishing days by 44-45% after 12 months (Connelly and Brown, 1995). Multiple electronic reporting apps currently exist in the United States, including iAngler, iSnapper, and Snapper Check, which largely target marine recreational anglers (Venturelli et al., 2016).

The South Atlantic Fisheries Management Council (SAFMC), the regional council that manages fisheries in North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida, implemented a voluntary electronic reporting app and website in 2017 called MyFishCount (MFC). The program was intended to collect data around fishing of the snapper grouper complex, a group of 55 species that includes three sea bass species, 17 grouper species, 10 snapper species, seven porgy species, five grunt species, five jack species, three tilefish species, two triggerfish species, hogfish, spadefish and wreckfish. Historically, intercept data through MRIP for these species in the South Atlantic has been low, which could result in high levels of PSE and lower annual catch limits (SAMFC, 2018). The app was developed in partnership with the Snook and Gamefish Foundation and was intended to collect data on angler behavior and discards that could ultimately decrease PSE for snapper and grouper species and inform future fisheries management decisions (MFC, 2019)

SAFMC tested a pilot program of MFC during the recreational red snapper mini-season in fall 2017 and encouraged anglers to report their catch on MyFishCount.com. The website allowed anglers to log lengths and weights of their catch, photos of their fish, and information about discards. A total of 360 anglers created profiles, and 341 submitted trip data to the site (including trips that were "abandoned", where anglers intended to fish but could not due to weather or other factors) (SAFMC, 2017). These data were considered by the National Marine Fisheries Service when they decided to extended the recreational red snapper season for an additional weekend later that year. When the app was launched in summer of 2018, anglers had the option to submit data through either the website or the app. However, neither the website nor the app collected information regarding angler perceptions of the snapper grouper fishery or electronic reporting, leaving gaps in knowledge as to why anglers chose to participate (or not) in MyFishCount.

We developed two surveys to evaluate what motivates anglers to electronically report catch and identify modifications to MyFishCount that would make anglers more likely to use it. The purpose of the study is to provide SAFMC and other fisheries management organizations with a more robust view of how anglers perceive the effectiveness of electronic reporting, and how likely they are to use reporting platforms, including MFC, on future trips.

The study addressed the following questions:

1. What is the perception of the recreational snapper grouper fishery in the South Atlantic?

2. What are the attitudes, perceptions, and opinions of electronic recreational reporting that might influence an angler's behavior to electronically report?

3. What modifications or improvements to MyFishCount might make anglers more likely to use to app to electronically report?

Data regarding perceptions and motivations could ultimately help SAFMC, and other organizations trying to implement electronic reporting, more effectively design outreach to anglers and improve the user experience of their reporting apps and websites. A better understanding of what encourages—or discourages—anglers from participating in electronic reporting can help managers direct time and money into marketing, designing, and implementing tools that are easily adoptable by anglers and collect usable data. A simple application of the survey data is how managers advertise the app: if anglers are more likely to try apps when they learn about it through social media instead of emails, for example, managers know they should spend more time promoting the program through channels like Facebook and Twitter rather than in email newsletters.

Methods

The study consisted of two voluntary online surveys, written in collaboration with SAFMC, which targeted recreational snapper grouper anglers in the Southeastern United States (IRB reference number: IRB Study #17-3349). Survey questions were designed to assess perceptions of electronic reporting and the snapper grouper fishery in the South Atlantic, and to determine factors that influence angler behavior. The surveys were emailed to over 3,000 anglers through SAFMC's email listserv and promoted on their Facebook and Twitter pages.

The initial survey was deployed in March 2018 and focused on general perceptions of electronic reporting, awareness of MFC, and willingness to try the platform (Appendix 1). A follow-up email was sent one week after the initial email announcement reminding anglers to participate. The second survey, which was released in November 2018, focused more

specifically on user experience of the app and website, and what motivates fishers to electronically report (Appendix 2). This survey also included questions that are part of a larger study by Dr. Chelsey Crandall at the University of Florida that assessed motivations of participants across many different recreational fishing reporting apps across the United States.

Both surveys included multiple choice questions, matrices, and short answer questions. Demographics questions were included in both surveys to get an overall view of what types of anglers are interested in electronic reporting, and to see if perceptions and motivations varied by age, number of years fishing, fishing location, and more. Survey participants were directed to one of four unique question pathways based on their past use of MFC: one addressing those who had never heard of MFC, one for those who had heard of MFC but did not sign up, one for those who signed up but did not submit a trip, and one for those who both signed up and submitted a trip. Responses were collected and analyzed through Qualtrics, and Kruskal-Wallis rank sum tests in R Studio were used to determine if there were correlations between demographic data and perception data.

If not specified in-text in Results, S1 and S2 are included after results to indicate which survey the question was asked (survey one in March and survey two in November, respectively).

Results

Participant demographics

Survey 1 and 2 had 285 and 122 participants respectively. In both surveys, over half of participants (54.7% and 57.45%, respectively) were from Florida (Table 1), over 90% of participants were male, and on average, participants were 55.4 years old. Participants had been fishing for snapper grouper for an average of 23.5 years (S1).

The majority of respondents (63.1%) took one or more private saltwater recreational fishing trips per month in the previous calendar year, with 22.8% of respondents taking one or more trips per week (S1). When asked about how many saltwater recreational trips they took targeting the snapper grouper complex over the past year (defined as any fishing trip where they actively targeted snapper grouper species for at least part of the time), 37% said they took 1-5 trips per year, and 63.6% said they took one or more snapper grouper trips per month (S1). The majority (>70%) of respondents said they fish in the spring, summer, and/or fall, but only 37.1% said they fish in the winter (S1).

Perceptions of the fishery

83.8% of anglers answered that snapper grouper species are among the most important recreational target species or the most important recreational target fish species in the South Atlantic (S1). Only 3.3% of respondents stated they were not an important fish species in the region (S1). 32% of respondents said that on snapper grouper trips they switch to target non-snapper grouper species frequently or always, and 21.5% stated they often switch target species (S1). Only 4.3% said they never switch target species on a snapper grouper trip.

Perceptions of reporting

37.9% of respondents thought reporting should be mandatory for at least some saltwater recreational fisheries, 32.8% thought it should be voluntary for all, and 14.2% thought there should not be any reporting at all (S1). The remaining respondents (15.1%) were undecided about how reporting should be structured (S1). When asked about their level of satisfaction with the current system of reporting (MRIP), 70% of respondents were at least "somewhat

dissatisfied", with 48.9% stated they were "very dissatisfied". Only 10.3% were "somewhat" or "very" satisfied (S1).

In both surveys, anglers were asked how well the thought MRIP estimated catch, and results varied with each survey (Table 2). Generally, more anglers thought MRIP overestimates catch than underestimates catch.

Anglers were asked to indicate on a scale of 1-5 how much they agreed or disagreed with certain statements about electronic reporting, with 1 being "strongly disagree" and 5 being "strongly agree". On average, anglers agreed that electronically-reporting information can be used to make informed management decisions (average score 3.64) and to determine season length (average score 3.49) (S1) (Figure 1).

When asked which methods NMFS should use to monitor saltwater recreational catch and effort, 60% said they should use a mobile reporting app and 54.5% said they should use a reporting website (S1). Only 5% said they should use paper logbooks, and 15.9% said they should use the current method of reporting (MRIP) (S1).

Almost half of respondents (49.1%) said self-reported data, like that collected in MyFishCount, is "sometimes reliable" (S2). 26.4% said it was "almost always reliable", 1.9% it was "always reliable", and 12.3% said it was "never reliable". 10.4% were unsure (S2).

Motivations to report

Anglers were asked to indicate on a scale of 1-5 how certain factors would encourage or discourage them from reporting, with 1 being "strongly discourages" and 5 being "strongly encourages" (Figure 2). "Other anglers believe electronic reporting will improve management" was the factor anglers said most strongly encouraged them to report (average score 3.50), closely

followed by “anglers similar to me electronically report” (average score 3.48) (S1). “Fisheries managers expect me to electronically report” had the lowest average score with 3.21 (S1).

Perceptions of MFC

The majority of participants (63.1% in S1 and 66.7% in S2) heard about MyFishCount through an email from SAFMC. In the first survey, of the participants who had heard of MyFishCount before the survey, 25.8% had submitted a trip, 12.4% made an account but did not submit a trip, and 61.8% did not make an account. In the second survey, 41.8% had submitted a trip, 23.1% made an account but did not submit a trip, and 35.2% did not make an account.

On average, those who did not make an account said they would consider signing up for MyFishCount in the future (average score of 3.59 when asked on a scale of 1-5 if they would sign up, where 1 was “strongly disagree” and 5 was “strongly agree”) (S1).

In both surveys, those who made an account (regardless of whether or not they submitted a trip) listed “I wanted to participate in fisheries management” as the most important factor that influenced their decision to make a MyFishCount account (Figure 3). The second most important factor was “I believe using MyFishCount will help my interests as an angler”.

Of those who made an account but did not submit a trip in the first survey, 54.5% said they did not submit a trip because they did not take a trip targeting snapper grouper after signing up. Of the six people who selected “other” reasons for not submitting, three stated that bad weather prevented them from fishing (S1). In the second survey, the most commonly-cited reason for not submitting a trip was also not taking a snapper grouper trip (31.6% of respondents).

Of those who made and account and submitted a trip, most agreed that the MyFishCount website is easy to navigate and is a fast way to report (average score of 3.48 and 3.63 when asked on a scale of 1-5, where 1 was "strongly disagree" and 5 was "strongly agree") (S1). Those who submitted a trip were more likely to agree with positive statements about MyFishCount than those who had not submitted a trip (Table 3) (S1).

MFC usability

The second survey included questions about the usability of the website and app. Of those who used MyFishCount, 32.7% accessed it through the website, 18.2% accessed it through the app, and 49.1% used both (S2). Most participants said it took as long as they expected to submit a trip (56%), while 36% said it took longer than they expected to submit a trip (S2). Similarly, most respondents said submitting a trip took as much effort as they expected (51.0%), and 31% said it took more effort than they expected (S2). On average, when asked on a scale of 1-5 how much they agreed or disagreed with statements about MyFishCount, participants who made an account said it was easy to set up an account (average score of 4.08) and that they enjoyed participating in MyFishCount (average score of 3.77) (S2). When asked to rate platform features on a scale of 1-5, those who submitted trips also had generally positive opinions, saying that they liked the platform design (average score of 3.64), the "Reporting Tips" feature was useful (average score of 4.16), and the "Data Uses" description helped them understand how their data would be used (average score of 4.41). Participants did, however, agree that it was difficult to view their previous trips within the platform (average score of 4.04) (S2). When asked how often participants would use MyFishCount on future snapper grouper trips, 30.8%

said they would use it on all of them, and 26.9% said they would use it on more than half of their trips. 11.5% said they would never use the platform on a future snapper grouper trip (S2).

Discussion

Survey participants were generally older (55+) males who are avid anglers. Although 90% of survey participants were male, males make up 68.4% of recreational saltwater fishery participants nationwide (Outdoor Foundation, 2017). On average, over 70% of recreational saltwater anglers fish less than once per month and less than 6% fish more than once per week, but the majority of survey participants fished once or more per month, and almost a quarter of participants fished more than once per week (Outdoor Foundation, 2017). A disproportionate representation from avid anglers in a voluntary survey could be representative of those more willing to receive SAFMC emails and follow them on social media, and/or those more engaged with fisheries management initiatives like electronic reporting. These findings align with previous work by Crandall et al. (2018), who found that participants in another electronic reporting program (the Angler Action Program) were primarily males who are avid fishers. Assessment of MyFishCount user demographics in comparison to the broader saltwater angler population is important to avoid avidity bias, where some users with high catch rates skew the results of electronically-reported data in comparison to the average (Jiorle et al., 2016).

As MyFishCount was initially marketed to snapper grouper fishers around the opening of the 2017 red snapper recreational season, it is unsurprising that in our survey about MyFishCount, the overwhelming majority of anglers consider snapper grouper species among the most important or the most important fish in the South Atlantic. However, with over half of respondents saying they switch to target non-snapper grouper species on over 50% of snapper

grouper trips, it suggests other species are regularly targeted by snapper grouper anglers. Understanding which species are fished on trips where anglers switch target species could help managers understand which species might experience increased fishing pressure when catch limits are restricted or population sizes of snapper grouper are low.

If there was one thing respondents agreed on, it was that they are dissatisfied with MRIP. In both surveys, almost half of respondents said MRIP overestimates catch, indicating that they believe regulations are established with inaccurate data that errs on the side of restricting catch more than needed. In both surveys, people indicated that they did not know how well MRIP estimated catch (12.3% of respondents in survey 1, and 26.8% in survey 2), indicating there is still some confusion about how MRIP data translates to catch estimates. However, the question about how well MRIP estimated catch was worded differently between the two surveys ("Please indicate your opinion of saltwater recreational catch estimates provided by the current recreational monitoring program (MRIP) for snapper grouper species" in survey 1, and "How well do you think current recreational catch monitoring efforts (like the Marine Recreational Information Program, or MRIP) estimate catch for snapper grouper species?" in survey 2). Confusion around question wording could have contributed to a higher number of respondents answering "I don't know" in the second survey. Also, "I am not familiar with MRIP" was included as an option in survey 2, but not survey 1, which could have contributed to variation in responses between the two surveys.

Despite the variation, a general dissatisfaction with MRIP and distrust in the resulting catch estimates indicates there is a strong level of frustration amongst anglers, which could facilitate them being receptive to new methods of reporting. Our results suggest that generally, anglers are supportive of voluntary reporting, with about a third supporting mandatory reporting

for at least some fisheries. Also, there is still a segment of the population that is unsure how they feel about reporting and could potentially benefit from additional outreach and education. Our results suggest there is still concern about the reliability of self-reported electronic data, and additional research to determine *why* anglers think self-reported data is only sometimes reliable could help direct education and monitoring efforts.

The majority of participants agreed that electronically reported information could be used to make informed management decisions, including ones regarding season length. Anglers were most in favor of using mobile reporting apps to collect data, followed by websites. Very few people were in support of paper logbooks and MRIP, indicating that most anglers are open and willing to using electronic reporting over traditional methods of reporting. Additional research is needed to determine whether these positive views are represented by the saltwater recreational population at large, rather than just those who participated in a voluntary survey about electronic reporting. Also, this survey likely did not capture participants who are unfamiliar with electronic reporting, who could have different perceptions of the method.

The ability to contribute to fisheries management and positive perceptions of fellow anglers seem to be the most important factors in snapper grouper anglers' decision to report electronically. Although all factors included in the survey generally encouraged anglers to report (average score of all factors that encourage/discourage anglers on a Likert scale were greater than 3.0, meaning on average they encourage anglers to report), the top three average scores were the three factors that related to perception and use of electronic reporting by other anglers. "Fisheries managers expect me to electronically report" was the only factor where over 10% of respondents said it would discourage them from reporting (22% said would discourage them). This suggests managers might be more successful in marketing electronic reporting apps through

word-of-mouth by anglers rather than directly from the management office, which could be perceived as pressuring anglers to participate.

Wanting to participate in fisheries management was the leading motivation for people to sign up for MyFishCount. This aligns with Crandall et al. (2018) who found that contributing to science was the primary reason people signed up for and continued to contribute to the Angler Action Program. The proportion of participants who agreed that MyFishCount will help their interests as anglers greatly outweighed those who disagree, which is promising as "other anglers believe electronic reporting will improve management" was the factor anglers said most strongly encouraged them to report. Sharing the results of the study, especially that 80% of participants believe MyFishCount helps their interests as anglers, could encourage anglers to start or continue using the app or website.

Although the most cited reason for not using MyFishCount (not taking a snapper grouper trip) is not something fisheries managers can change, the proportion of anglers who have not used MyFishCount will likely decrease as time goes on and anglers have more opportunities to take snapper grouper trips. Also, as those who submitted a trip were more likely to agree with positive statements about MyFishCount than those who had not submitted a trip, continued assessment of could show more positive perceptions towards the platform as time goes on.

Interviews with anglers from a broader demographic range (including gender, age, and avidity) could help assess potential bias in responses to these voluntary surveys. Also, comparison of perceptions of anglers using other electronic reporting platforms could help fisheries managers understand common motivations between saltwater recreational fishers.

Overall, respondents had positive views of the potential for self-reported data to be used in management, but have reservations about the reliability of the data. Their motivation to

participate seemed to be driven by a dissatisfaction in the current methods of reporting and a desire to be involved in the data collection and management process. They are also influenced by other anglers who report and who have positive opinions of reporting, suggesting outreach through other anglers might be an effective way of increasing participation in MyFishCount. Although there were not correlations between demographic variables and perceptions and motivations around electronic reporting, additional surveys of a more demographically diverse group of anglers would give a more wholistic view of how different populations view reporting.

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TABLES AND FIGURES

Table 1. State of residence demographics of the two surveys.

State	Survey 1 (%)	Survey 2 (%)
North Carolina	20.6	14.89
South Carolina	16.1	19.15
Georgia	8.6	8.51
Northern Florida (north of Cape Canaveral)	32.5	44.68
Southern Florida (South of Cape Canaveral)	22.2	12.77

Table 2: Differences in responses between the two surveys when participants were asked how well MRIP estimates catch.

Response	Survey 1 (%)	Survey 2 (%)
Severely underestimates	10.9	11.3
Moderately underestimates	11.8	17.5
Accurately estimates	2.6	5.2
Moderately overestimates	24.0	18.6
Severely overestimates	38.0	20.6
I don’t know	12.3	26.8

Table 3. Difference in average score on a Likert scale of responses to statements about MyFishCount. The question asked participants to say how much they agreed or disagreed with a statement with 1 representing "strongly disagree" and 5 representing "strongly agree".

	Respondents who did not make an account	Respondents who make an account but **did not** submit a trip	Respondents who made and account **and** submitted a trip
"Using MyFishCount will help further my interests as an angler"	3.12	3.32	3.51
"Data from MyFishCount will provide accurate data about the snapper grouper fishery"	3.04	3.18	3.5
"Using MyFishCount will help increase the number of fish I am allowed to catch in the future.	N/A	2.73	2.96
I would recommend MyFishCount to a friend. "	N/A	3.5	3.76

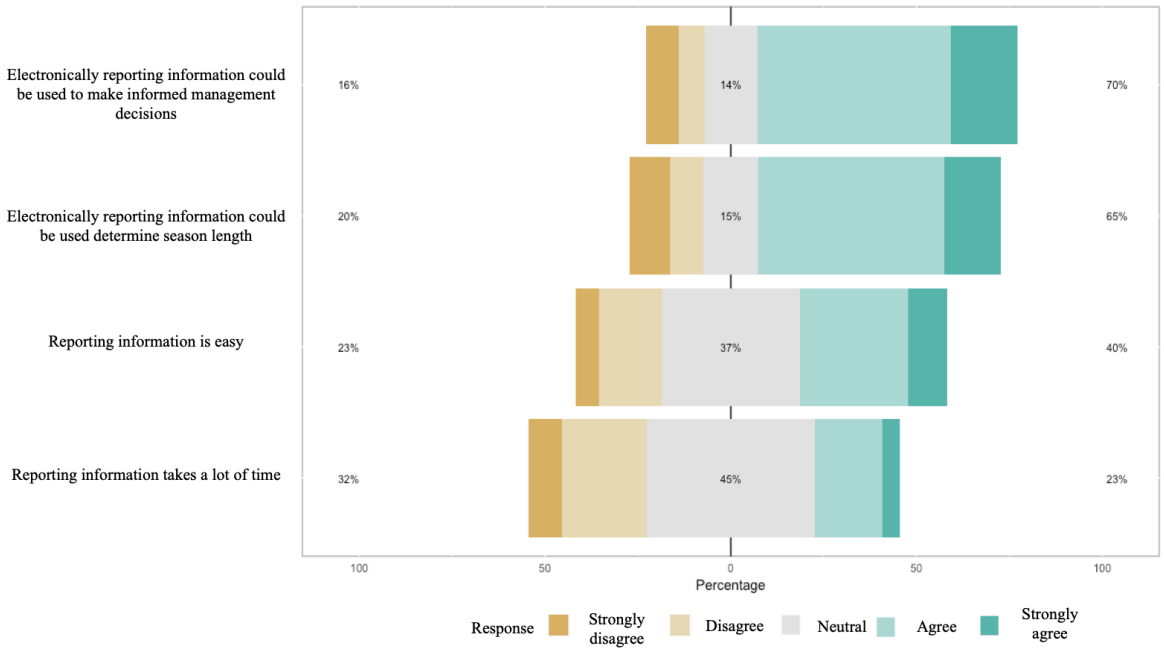

Figure 1: Angler perceptions of electronic reporting.

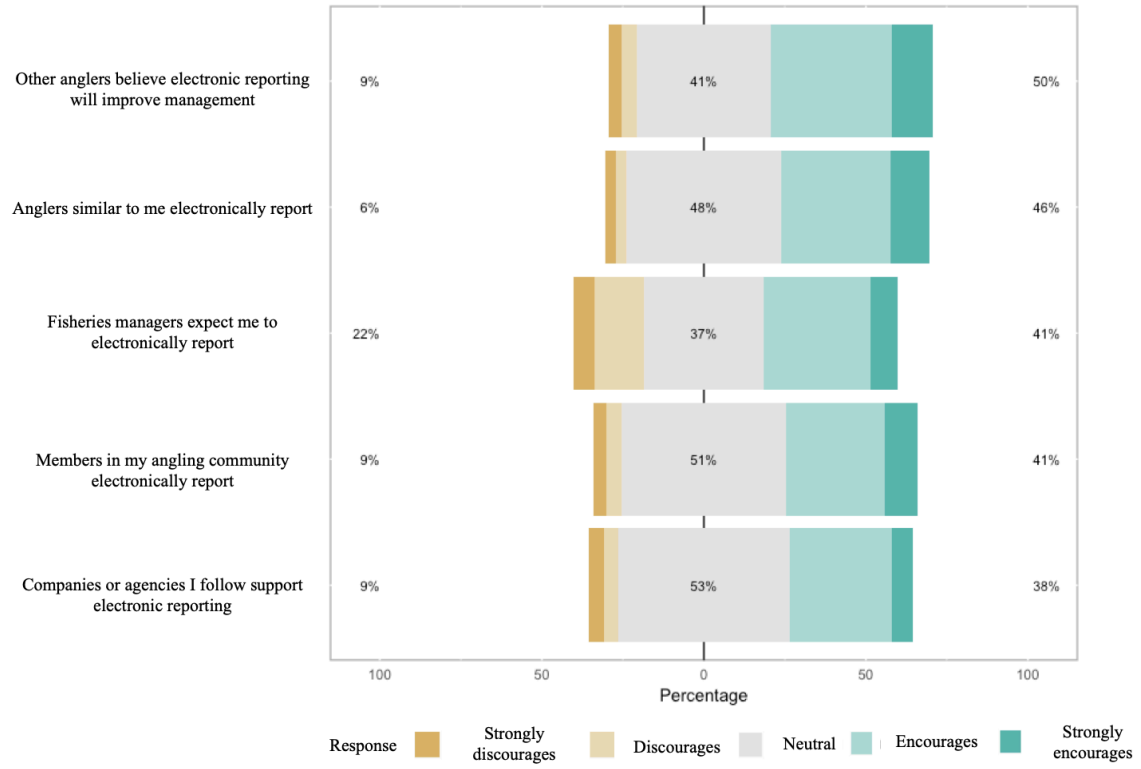

Figure 2: Angler motivations to electronically report.

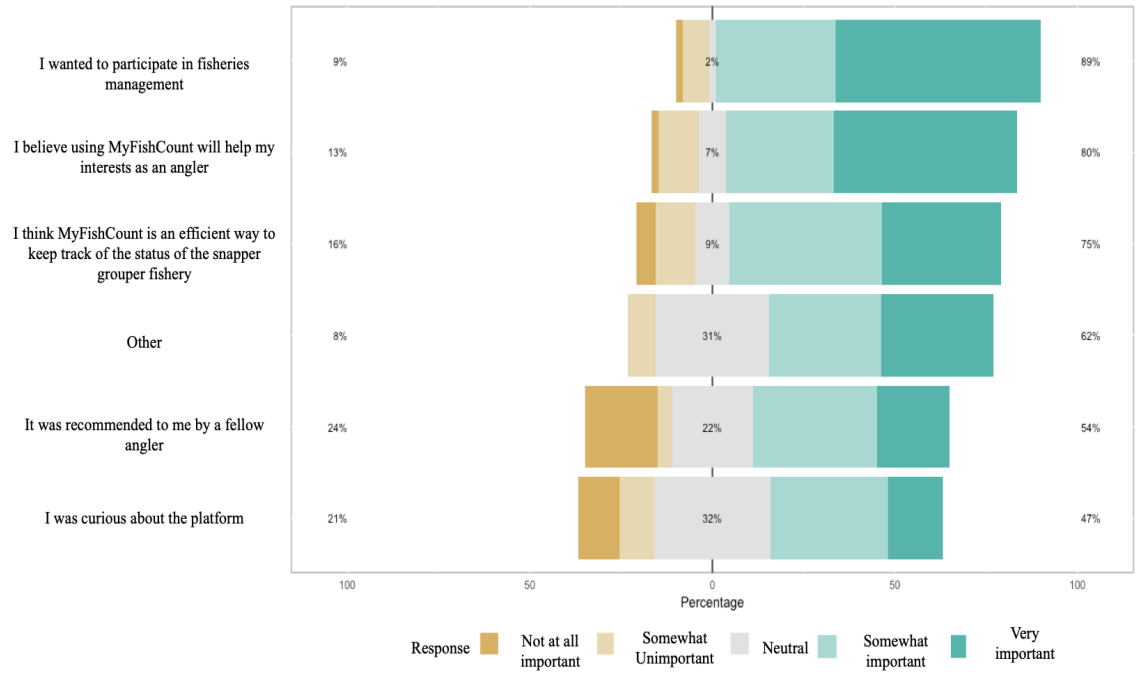

Figure 3: Angler motivations to sign up for MyFishCount.

APPENDIX 1: SNAPPER GROUPER RECREATIONAL REPORTING SURVEY

Thank you for your interest in participating in this survey! The purpose of this research study is to assess recreational angler perceptions of the South Atlantic snapper grouper fishery and electronic reporting. The survey also contains questions about the recreational electronic reporting pilot platform, MyFishCount, available to anglers during the fall 2017 red snapper mini-season. This survey is conducted through the graduate school at University of North Carolina – Chapel Hill.

The survey should take around 10 minutes to complete. There are no correct or incorrect responses and you may stop the survey at any time. You must be at least 18 years or older to participate. If you are younger than 18 years old, please stop now. To protect your identity as a research subject, all responses to the survey will be anonymous. In any publication of this research, your name or other private information will not be used.

If you have any questions about this research, please contact Erin Spencer by calling 410-303-6638 or emailing etspencer@unc.edu. If you have questions or concerns about your rights as a research subject, you may contact the UNC Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu (reference number: IRB Study #17-3349).

Throughout the survey, we will refer to "snapper grouper species", which indicates the 55 species that make up the snapper grouper complex. This complex includes three sea bass species, 17 grouper species, 10 snapper species, seven porgy species, five grunt species, five jack species, three tilefish species, two triggerfish species, hogfish, spadefish and wreckfish. Click here for a complete list of species.

1. Please indicate from which state/area you generally fish from.

- o North Carolina
- o South Carolina
- o Georgia
- o Northern Florida (Cape Canaveral and North)
- o Southern Florida (South of Cape Canaveral)

2. How many private saltwater recreational fishing trips did you take in the last calendar year?

- o 0 trips
- o 1-5 trips per year
- o 6-10 trips per year
- o 1 trip per month
- o 2-3 trips per month
- o 1 trip per week
- o > 1 trip per week

3. How many private saltwater recreational fishing **snapper grouper** trips did you take in the last calendar year? Consider a snapper grouper trip as any fishing trip where you actively targeted snapper grouper species for at least part of the time.

- o 0 trips
- o 1-5 trips per year
- o 6-10 trips per year
- o 1 trip per month
- o 2-3 trips per month
- o 1 trip per week
- o >1 trip per week

4. How many years have you been snapper grouper fishing?

5. How do you think reporting should be structured for saltwater recreational fisheries?

- o Mandatory for all saltwater recreational fisheries
- o Mandatory for some but not all saltwater recreational fisheries
- o Voluntary for saltwater recreational fisheries
- o I do not think there should be any reporting for saltwater recreational fisheries
- o I am undecided about reporting for recreational fisheries

6. Please indicate your level of satisfaction with the current recreational monitoring program (MRIP) that estimates recreational catch and effort for private recreational snapper grouper anglers.

- o Very satisfied
- o Somewhat satisfied
- o Neither satisfied nor dissatisfied
- o Somewhat dissatisfied
- o Very dissatisfied
- o I am not familiar with the monitoring program
- o I do not have an opinion of catch rate estimates

7. Please indicate your opinion of saltwater recreational catch estimates provided by the current recreational monitoring program (MRIP) for snapper grouper species.

- o Severely underestimates catch
- o Moderately underestimates catch
- o Accurately estimates catch
- o Moderately overestimates catch
- o Severely overestimates catch
- o I am not familiar with the catch estimates

8. Please indicate how each of the following would encourage or discourage you from reporting electronically.

	Strongly discourages me from reporting	Discourages me from reporting	Neither encourages nor discourages me from reporting	Encourages me to report	Strongly encourages me to report
Members in my angling community electronically report	○	○	○	○	○
Anglers similar to me electronically report	○	○	○	○	○
Fisheries managers expect me to electronically report	○	○	○	○	○
Other anglers believe electronic reporting will improve management	○	○	○	○	○
Companies or agencies I follow support electronic reporting	○	○	○	○	○

9. Please indicate how much you agree or disagree with the following statements.

	N/A	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Electronically reported Information could be used to make informed management decisions	○	○	○	○	○	○
Electronically reported information could be used to determine season length	○	○	○	○	○	○
Reporting information is easy	○	○	○	○	○	○
Reporting information takes a lot of time	○	○	○	○	○	○

10. Please indicate how you think the National Marine Fisheries Service should monitor recreational catch and effort for private saltwater recreational anglers. More than one answer may be selected.

- ○ Through a mobile reporting app
- ○ Through paper log books
- ○ Through an online electronic reporting website
- ○ Through the current recreational monitoring system
- ○ I do not think private recreational anglers should report
- ○ I do not have an opinion on private recreational reporting

11. How did you hear about MyFishCount? Select all that apply.

- From a SAFMC email
- On social media (please indicate Facebook, Twitter, or other)
- From a fellow angler
- From the South Atlantic Fisheries Management Council website
- From a fishing organization (ex: CCA, ASA, Snook and Gamefish Foundation, etc.)
- Other (please specify)
- I did not hear about MyFishCount before this survey

Skip To end of block if "How did you hear about MyFishCount"? = "I did not hear about MyFishCount before this survey"

12. Did you make an account on the MyFishCount website?

- Yes, I made an account AND submitted a trip
- Yes, I made an account but did NOT submit a trip
- No, I was aware of MyFishCount but did not make an account

Display this question if "Did you make an account on the MyFishCount website?" = "Yes, I made an account but did NOT submit a trip"

13. Why did you choose not to submit a trip through MyFishCount? (select all that apply)

- I did not take a trip targeting red snapper after signing up for MyFishCount
- The submission process was too time consuming
- The submission process was confusing
- I forgot to submit my trip to MyFishCount
- Other (please specify)

Display this question if "Did you make an account on the MyFishCount website?" is not = "No, I was aware of MyFishCount but did not make an account"

We are very interested in understanding why people participated in reporting through MyFishCount during the 2017 red snapper mini-season. Please answer the following questions regarding your own motivations to participate.

Display this question if "Did you make an account on the MyFishCount website?" is not = "No, I was aware of MyFishCount but did not make an account"

14. Why did you create a MyFishCount account? (select all that apply)

- o It was recommended to me by a fellow angler
- o I believe using MyFishCount will help my interests as an angler
- o I was curious about the platform
- o I wanted to participate in fisheries management
- o MyFishCount is a more efficient way to keep track of the status of the snapper grouper fishery than other electronic reporting systems
- o Other (please specify)

Display this question if "Did you make an account on the MyFishCount website?" = "Yes, I made an account but did NOT submit a trip"

15. After signing up for MyFishCount, please indicate how much you agree or disagree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The website is easy to navigate	○	○	○	○	○
I would use MyFishCount on future trips	○	○	○	○	○
I would recommend MyFishCount to a friend	○	○	○	○	○
Using MyFishCount will help further my interests as an angler	○	○	○	○	○
Using MyFishCount will help increase the number of fish I am allowed to catch in the future	○	○	○	○	○
Data from MyFishCount will provide accurate data about the snapper grouper fishery	○	○	○	○	○
The information provided by the MyFishCount Red Snapper mini-season report issued by SAFMC was of interest to me as an angler	○	○	○	○	○

Display this question if "Did you make an account on the MyFishCount website?" = "Yes, I made an account AND submitted a trip"

16. After submitting a trip through MyFishCount, please indicate on a scale of 1-5 how much you agree or disagree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The website is easy to navigate.	○	○	○	○	○
I would use MyFishCount on future trips.	○	○	○	○	○
MyFishCount is a fast way to report.	○	○	○	○	○
I would recommend MyFishCount to a friend.	○	○	○	○	○
Using MyFishCount will help further my interests as an angler.	○	○	○	○	○
Using MyFishCount will help increase the number of fish I am allowed to catch in the future.	○	○	○	○	○
Data from MyFishCount will provide accurate data about the snapper grouper fishery.	○	○	○	○	○
The information provided by the MyFishCount Red Snapper mini-season report issued by SAFMC was of interest to me as an angler.	○	○	○	○	○

Display this question if "Did you make an account on the MyFishCount website?" = "No, I was aware of MyFishCount but did not make an account"

17. Please indicate how much you agree or disagree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I feel that I understand the project goals behind MyFishCount	○	○	○	○	○
I would consider signing up for MyFishCount in the future	○	○	○	○	○
Using MyFishCount will help further my interests as an angler	○	○	○	○	○
Data from MyFishCount will provide accurate data about the snapper grouper fishery	○	○	○	○	○

Display this question if "Did you make an account on the MyFishCount website?" is not = "No, I was aware of MyFishCount but did not make an account"

18. How often would you use MyFishCount in the future? Please state answer in percent of future trips.

Display this question if "Did you make an account on the MyFishCount website?" is not = "No, I was aware of MyFishCount but did not make an account"

19. What do you like most about the MyFishCount reporting platform?

Display this question if "Did you make an account on the MyFishCount website?" is no = "No, I was aware of MyFishCount but did not make an account"

20. What do you like least about MyFishCount reporting platform?

21. On snapper grouper trips, how often do you switch to targeting non-snapper grouper species?

- o I never switch to target other species
- o Rarely (<25% of the time)
- o Sometimes (25-50% of the time)
- o Often (50-75% of the time)
- o Frequently (75-99% of the time)
- o I always switch to target other species
- o I do not take snapper grouper trips

22. Compared to other species in the South Atlantic, how important is fishing for snapper grouper species to you?

- o Snapper grouper species are the most important target species
- o Snapper grouper species among the most important target species
- o Snapper grouper species are neither important nor unimportant
- o Snapper grouper species are among the least important target species
- o Snapper grouper species are not important target species

23. During what season(s) do you typically snapper grouper fish? Please check all that apply.

- o Fall
- o Winter
- o Spring
- o Summer
- o I do not fish for snapper grouper

24. Are you affiliated with any angling clubs? Please, indicate below.

25. Please indicate your State of residence.

- o North Carolina
- o South Carolina
- o Georgia
- o Northern Florida (Cape Canaveral and North)
- o Southern Florida (South of Cape Canaveral)

26. What is your age?

27. What best describes your gender?

- o Male
- o Female
- o Not listed

28. Please provide any additional comments about MyFishCount and saltwater recreational reporting for snapper grouper in the South Atlantic.

APPENDIX 2: SNAPPER GROUPER RECREATIONAL REPORTING SURVEY FOLLOW UP

Thank you for your interest in participating in this survey! The purpose of this research study is to assess recreational angler perceptions of the South Atlantic snapper grouper fishery and electronic reporting. The survey also contains questions about the recreational electronic reporting pilot platform, MyFishCount. MyFishCount is available online and through an app which became live in June 2018. This survey is a follow up to a survey from March 2018, but everyone is encouraged to participate regardless of whether or not you took the previous survey. The survey should take around 15 minutes to complete. There are no correct or incorrect responses and you may stop the survey at any time. You must be at least 18 years or older to participate. If you are younger than 18 years old, please stop now. To protect your identity as a research subject, all responses to the survey will be anonymous. In any publication of this research, your name or other private information will not be used.

This survey is conducted through the graduate school at University of North Carolina – Chapel Hill. If you have any questions about this research, please contact Erin Spencer by calling 410-303-6638 or emailing etspencer@unc.edu. If you have questions or concerns about your rights as a research subject, you may contact the UNC Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu (reference number: IRB Study #17-3349).

Throughout the survey, we will refer to "snapper grouper species", which indicates the 55 species that make up the snapper grouper complex. Snapper grouper species are species typically associated with hard bottom, coral, and artificial reefs which are targeted by fishermen. This complex includes three sea bass species, 17 grouper species, 10 snapper species, seven porgy species, five grunt species, five jack species, three tilefish species, two triggerfish species, hogfish, spadefish and wreckfish. Click here for a complete list of species.

1. How did you hear about MyFishCount? Select all that apply.

- From a South Atlantic Fisheries Management Council email
- On social media (please indicate Facebook, Twitter, or other)
- From a fellow angler
- From the South Atlantic Fisheries Management Council website
- From a fishing organization (ex: CCA, ASA, Snook and Gamefish Foundation, etc.)
- Other (please specify)
- I did not hear about MyFishCount before this survey

2. How well do you think current recreational catch monitoring efforts (like the Marine Recreational Information Program, or MRIP) estimate catch for snapper grouper species?

- Severely underestimates catch
- Moderately underestimates catch
- Accurately estimates catch
- Moderately overestimates catch
- Severely overestimates catch
- I don't know how well it estimates catch
- I am not familiar with the Marine Recreational Information Program

3. In your opinion, how reliable is self-reported data (like that collected through MyFishCount)?

- Never reliable
- Sometimes reliable
- Almost always reliable
- Always reliable
- I'm not sure

4. Did you make an account on the MyFishCount website or app?

- Yes, I made an account AND submitted a trip
- Yes, I made an account but did NOT submit a trip
- No, I was aware of MyFishCount but did not make an account
- No, I did not hear about MyFishCount before this survey

Display this question if "Did you make an account on the MyFishCount website or app?" = "Yes, I made an account AND submitted a trip" or "Did you make an account on the MyFishCount website or app?" = "Yes, I made an account but did NOT submit a trip"

5. Listed below are reasons fisherman may participate in MyFishCount. Please indicate how these reasons (if any) influenced your decision to create a MyFishCount account.

	Not at all important	Somewhat unimportant	Neither important nor unimportant	Somewhat important	Very important
It was recommended to me by a fellow angler	○	○	○	○	○
I believe using MyFishCount will help my interests as an angler	○	○	○	○	○
I was curious about the platform	○	○	○	○	○
I wanted to participate in fisheries management	○	○	○	○	○
I think MyFishCount is an efficient way to keep track of the status of the snapper grouper fishery	○	○	○	○	○
Other (please specify in box below)	○	○	○	○	○

Display this question if "Did you make an account on the MyFishCount website or app?" = "Yes, I made an account but did NOT submit a trip"

6. Why did you choose not to submit a trip through the MyFishCount? (select all that apply)

- o I did not take a recreational fishing trip after signing up for MyFishCount
- o The submission process (on the app or web portal) was time consuming
- o The submission process (on the app or web portal) was confusing
- o I forgot to submit my trip to MyFishCount
- o I don't think MyFishCount is useful
- o I experienced an error with the app
- o I experienced an error with the web portal
- o Other (please specify)

Display this question if "Did you make an account on the MyFishCount website or app?" = "No, I was aware of MyFishCount but did not make an account" Or "Did you make an account on the MyFishCount website or app?" = "No, I did not hear about MyFishCount before this survey"

If you have not made an account with MyFishCount, we encourage you to do so now. We would greatly appreciate your feedback about the website and/or mobile app on iPhone or Android. If you don't have a trip to submit, you can select "test" from the "Trip Type" dropdown menu. Your first impressions will help us create a better experience for all users!

Display this question if "Did you make an account on the MyFishCount website or app?" = "Yes, I made an account but did NOT submit a trip"

If you have not yet submitted a trip through MyFishCount, we encourage you to do so now! If you don't have a trip to submit, you can select "test" from the "Trip Type" dropdown menu. Your first impressions will help us create a better experience for all users!

7. How did you access MyFishCount?

- o Using the MyFishCount website
- o Using the MyFishCount app on my phone
- o Using both the website and the app
- o I have not used MyFishCount

Skip to end of survey if "How did you access MyFishCount?" = "I have not used MyFishCount"

8. Overall, how much you agree or disagree with the following statements about MyFishCount?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
It was easy to create a username and password for MyFishCount	○	○	○	○	○
I will use my MyFishCount account to look at my past trips	○	○	○	○	○
MyFishCount gives managers important information about fisheries stocks	○	○	○	○	○
It was easy to submit a trip	○	○	○	○	○
I felt uncomfortable sharing my information	○	○	○	○	○
I know how to contact SAFMC if I encounter a problem with MyFishCount	○	○	○	○	○
I would use MyFishCount to submit trips while on the water	○	○	○	○	○
I trust my fellow volunteers	○	○	○	○	○
I enjoy participating in MyFishCount	○	○	○	○	○

9. Compared to your expectations, how long did it take you to submit a trip through MyFishCount?

- o Much longer
- o Slightly longer
- o What I expected
- o Slightly faster
- o Much faster

10. Overall, how much you agree or disagree with the following statements about the MyFishCount?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I experienced an error	I did not use this
It was difficult to view my previous trips	○	○	○	○	○	○	○
I like the platform design	○	○	○	○	○	○	○
The “Reporting Tips” were useful	○	○	○	○	○	○	○
The “Data Uses” section helped me understand how my data will be used	○	○	○	○	○	○	○
The drop-down options for “Trip Information” accurately reflected my trip	○	○	○	○	○	○	○
My target species was not listed in the drop-down options	○	○	○	○	○	○	○

11. How easy was it to use MyFishCount compared to your expectations?

- Significantly easier
- Slightly easier
- It took as much effort as I expected
- Slightly harder
- Significantly harder

12. Is there any other information you think anglers should be able to report through MyFishCount?

13. Are there any questions included in the MyFishCount submission process that you think are unnecessary?

Display this question if "How did you access MyFishCount?" = "Using both the website and the app"

14. Would you prefer to use the MyFishCount app OR website when reporting future trips?

- I prefer to use the app
- I prefer to use the website
- I would submit through either the app or website
- I would not use MyFishCount to report future trips

15. How often do you think you will use MyFishCount to submit snapper grouper trips?

- Never
- Less than half my trips
- Half of my trips
- More than half of my trips
- All my trips

16. Are there any changes SAFMC could make to MyFishCount that would make you *more likely* to submit trips?

17. What do you like **most** about the MyFishCount reporting platform?

18. What do you like **least** about the MyFishCount reporting platform?

19. On a scale of 1-5, how important were each of the following in motivating you to report through MyFishCount?

	1. Not at all important	2	3	4	5. Very important
Improving the quality of fisheries data	○	○	○	○	○
Improving my fishing experiences	○	○	○	○	○
Improving fishing for other anglers like me	○	○	○	○	○
Improving fisheries for the enjoyment of all	○	○	○	○	○
Learning more about fisheries science	○	○	○	○	○
Learning about my own fishing	○	○	○	○	○
The opportunity to gain a new perspective on things	○	○	○	○	○
Benefiting scientists	○	○	○	○	○
Contributing to original research	○	○	○	○	○
Feeling part of the community of volunteer anglers	○	○	○	○	○

20. On a scale of 1-5, how important were each of the following in motivating you to report through MyFishCount? (continued)

	1. Not at all important	2	3	4	5. Very important
Helping my in my chosen profession	○	○	○	○	○
Making new contacts that might help my career	○	○	○	○	○
Feeling good about my contribution	○	○	○	○	○
The attitudes of my friends and family regarding my participation	○	○	○	○	○
Enhancing my status in the fishing community	○	○	○	○	○
Advancing the goals of the MyFishCount pilot project	○	○	○	○	○
Showing concern and compassion for others	○	○	○	○	○
Making the world a better place	○	○	○	○	○

21. Are you affiliated with any angling clubs? Please, indicate below.

22. Please indicate your State of residence.

- o North Carolina
- o South Carolina
- o Georgia
- o Northern Florida (Cape Canaveral and North)
- o Southern Florida (South of Cape Canaveral)

23. What is your age?

24. What is your gender?

25. Please provide any additional comments about MyFishCount and saltwater recreational reporting for snapper grouper in the South Atlantic.